

03/02/00
Jc780 U.S. PTO

UTILITY PATENT APPLICATION TRANSMITTAL

Under Small Entity Status

(New Nonprovisional Applications Under 37 CFR § 1.53(b))

Attorney Docket No.

800448

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

Transmitted herewith is the patent application of () application identifier or (X) first named inventor, Vlado Ostovic, entitled Means For Field Control In Permanent Magnet Electric Machines, for an:

- (X) Original Patent Application.
- () Continuing Application (prior application not abandoned):
- () Continuation () Divisional () Continuation-in-part (CIP)
of prior application No: _____ Filed on: _____
- () A statement claiming priority under 35 USC § 120 has been added to the specification.

Enclosed are:

- (X) Specification; 15 Total Pages. (X) Drawing(s); 4 Total Sheets.
- () Oath or Declaration:
- (X) A Newly Executed Combined Declaration and Power of Attorney:
- (X) Signed. () Unsigned. () Partially Signed.
- () A Copy from a Prior Application for Continuation/Divisional (37 CFR § 1.63(d)).
- () Incorporation by Reference. The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied, is considered as being part of the disclosure of the accompanying application and is hereby incorporated herein by reference.
- () Signed Statement Deleting Inventor(s) Named in the Prior Application. (37 CFR § 163(d)(2)).
- () Power of Attorney. (X) Return Receipt Postcard.
- () Associate Power of Attorney. (X) A Check in the amount of \$ 546.00 for the Filing Fee.
- () Preliminary Amendment. () Information Disclosure Statement and Form PTO-1449.
- () A Duplicate Copy of this Form for Processing Fee Against Deposit Account.
- () A Certified Copy of Priority Documents (if foreign priority is claimed).
- (X) Statement(s) of Status as a Small Entity.
- () Statement(s) of Status as a Small Entity Filed in Prior Application, Status Still Proper and Desired.
- () Other: _____

CLAIMS AS FILED				
FOR	NO. FILED	NO. EXTRA	RATE	FEE
Total Claims	25	5	\$9.00	\$ 45.00
Independent Claims	7	4	\$39.00	\$ 156.00
Multiple Dependent Claims (if applicable)				\$0.00
Assignment Recording Fee				\$0.00
Basic Filing Fee				\$345.00
Total Filing Fee				\$ 546.00

Charge \$ _____ to Deposit Account _____ pursuant to 37 CFR § 1.25. At any time during the pendency of this application, please charge any fees required or credit any overpayment to this Deposit Account.

Respectfully submitted,

By: Gail M. Taylor Russell
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**STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(b)) -- INDEPENDENT INVENTOR**

Docket Number
800448

Applicant, Patentee, or Identifier: Vlado Ostovic

Application or Patent No.: To be assigned

Filed or Issued: Filed herewith

Title: Means For Field Control In Permanent Magnet Electric Machines

As a below named inventor, I hereby state that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a non-profit organization under 37 CFR 1.9(e).

Each person concern, or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such persons, concerns, or organizations exist.
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Separate verified statements are required from each named person, concern, or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

Vlado Ostovic
NAME OF INVENTOR

Vlado Ostovic
Signature of Inventor

Feb. 18, 2000
Date

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MEANS FOR FIELD CONTROL IN PERMANENT MAGNET ELECTRIC MACHINES

by Vlado Ostovic of Weinheim, Germany

5

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to electrical machines, and more particularly, to synchronous machines with permanent magnets.

BACKGROUND

10

Synchronous machines with permanent magnets find application in various electric drives fed from inverters due to their high efficiency and no need for rotor cooling. These two advantages, along with minimum rotor maintenance need (no slip rings and brushes), make a permanent magnet (PM) synchronous machine the choice number one in numerous applications, when compared with a wound rotor synchronous machine.

15

The better utilization of rotor volume in a PM machine has, however, a price. The induced voltage in the stator winding of a wound rotor synchronous machine can be controlled by the field current. This possibility does not exist in a conventional PM synchronous machine, since the magnetization of permanent magnets is constant. When the speed of a wound rotor synchronous machine increases, its stator induced voltage can be kept constant or decreased by decreasing the field current. When, however, the speed of a PM synchronous machine increases, its stator induced voltage increases proportionally. At certain speed the stator induced voltage reaches the maximum allowed amount, determined by winding insulation properties and inverter voltage capability. Above that speed the drive cannot operate safely due to risk of equipment damage.

20

Another characteristic of a conventional PM synchronous machine is its constant number of poles. This is not always the case in a squirrel cage induction machine, the rotor of which has as many poles as its stator. By changing the number of stator poles in a squirrel cage induction machine, the number of rotor poles changes too, which enables machine generate torque at any pole number. This way, the speed range of a squirrel cage induction machine can be extended:

- In a ratio 2:1 with Dahlander connected stator winding;
- In a ratio $p : (p \pm 2)$ with pole- amplitude modulated (PAM) stator winding, where p stands for the number of poles
- In an arbitrary ratio with pole- phase modulated (PPM) stator winding with toroidal coils, as shown in US Patent 5,977,679.

On the other hand, a conventional PM rotor has a rigid magnetic structure which does not allow any change of the number of poles. Therefore, the speed range of a conventional synchronous machine with PM rotor cannot be increased by changing the number of its poles. Any attempt to change the number of stator poles without changing the number of rotor poles of an electric machine results in machine malfunctioning. A PM machine with different number of stator and rotor poles draws excessive currents from the source, without delivering any useful mechanical torque on the shaft.

When loaded, a conventional PM synchronous machine demonstrates another shortcoming: the load currents in the stator winding create their own magnetic field which distorts the field of permanent magnets (armature reaction). Since the field of permanent magnets has a constant amplitude and is fixed to the rotor surface, the load current distorts the resulting air gap field. This way, the stator induced voltage becomes a function of the load current, limiting possible applications of a conventional PM synchronous machine as a generator.

SUMMARY

The present invention is directed to overcoming the problems related to rigid rotor magnetization and single-speed capability in conventional PM machines. Briefly summarized, both the shape and magnitude of magnetic field distribution along the rotor circumference are controlled in this invention by means of current(s). The control current(s) can flow only during time interval in which a new magnetic state is created, or permanently. When the rotor magnetization is controlled by additional stator currents, the stator of the proposed machine draws during regular run only the load current.

A rotor of a synchronous machine has iron pole segment (1) and two or more tangentially magnetized permanent magnets (2), (3) per pole with different radial dimensions. On the stator side a conventional AC winding carries stator currents during normal operation. During short remagnetization phase an additional component of stator current provides for change of magnetization direction in a portion of longer magnets.

A rotor of a synchronous machine has two iron pole segments (4), a pole piece (24), and a trapezoidally shaped permanent magnet (5) per pole. A conventional AC winding on the stator side carries during a short period of time an additional current component, which remagnetizes a portion of the magnet closer to the rotor bore. The radial height of the remagnetized magnet portion is proportional to the remagnetizing current.

A rotor of a synchronous machine has optional squirrel cage bars (25), along with several trapezoidally formed iron yoke segments (6) and rectangular permanent magnets (7) per pole. The stator (8) is slotted, whereas the slots (9) carry a pole changing Dahlander winding, or a pole- amplitude modulated (PAM) winding, or a pole- phase modulated (PPM) winding with toroidal coils, as described in US Patent 5,977,679.

When the stator number of poles is changed, the stator winding draws temporarily an additional component of current which remagnetizes the rotor magnets in such a manner that the number of rotor poles is equal to the number of stator poles. The optional rotor cage generates torque which can bring the rotor into new synchronous speed after changing the number of poles.

5 A rotor of a synchronous machine has optional squirrel cage bars (26), along with several rectangular iron yoke segments (10) and trapezoidal permanent magnets (11) per pole. The stator (12) is slotted, whereas slots (13) carry a pole changing Dahlander winding, or a pole- amplitude modulated (PAM) winding, or a pole- phase modulated (PPM) winding with toroidal coils, as described in US Patent 5,977,679.

10 When the stator number of poles is changed, the stator winding draws temporary an additional component of current which remagnetizes the rotor magnets in such a manner that the number of rotor poles is equal to the number of stator poles. The optional rotor cage generates torque, which can bring the rotor into new synchronous speed after changing the number of poles. After changing the number of poles, the stator winding can carry during a short period of
15 time an additional current component which remagnetizes portions of the magnets closer to the rotor bore. The size of remagnetized magnet portion is proportional to the amplitude of remagnetizing current.

A rotor of a synchronous machine has two magnets per pole, the main magnet (14) and the auxiliary magnet (15), as well as iron segments (16). The main magnet provides for machine
20 excitation. The auxiliary magnet compensates for the armature reaction field created by the stator current.

A rotor of a synchronous machine has one magnet per pole (18), one iron segment per pole (19), and several independently driven coils per pole (17). The coil currents are chosen so to

create the magnetic field which acts in the same direction as the magnet field, or to be spatially shifted to the magnet field. In the former case, the coil current helps control the amount of induced voltage in the stator winding. In the latter case, the coil current can compensate for armature reaction of the stator winding.

5 A rotor of a synchronous machine has one tangentially (21) and one radially (23) oriented magnet per pole, several independently driven coils (20), and iron segments (22). The three sources of magnetic flux (two magnets and coils) combine their action in such a manner to fully compensate for effects of stator armature reaction.

10 These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

15 These and other features, aspects and advantages of the present invention will become better understood with regard to the following description, appended claims and accompanying drawings where:

Fig. 1 is a view of a section of the rotor lamination, showing iron pole segments (1), short permanent magnets (2), and long permanent magnets (3). The directions of magnetization of permanent magnets are indicated with arrows.

20 Fig. 2 is a view of a section of the rotor lamination, showing iron pole segments (4), trapezoidal permanent magnets (5), and pole pieces (24).

Fig. 3 is a cross- sectional view of a portion of the stator and rotor lamination, showing iron segments of the rotor (6), rectangular shaped rotor permanent magnets (7), optional squirrel cage bars (25), and stator (8) with stator slots (9).

Fig. 4 is a cross- sectional view of a portion of the stator and rotor lamination, showing iron segments of the rotor (10), trapezoidal rotor permanent magnets (11), optional squirrel cage bars (26), and stator (12) with stator slots (13).

Fig. 5 is a perspective view of a portion of the rotor core showing main field permanent magnets (14), auxiliary magnets (15), and rotor yoke soft magnetic material segments (16).

Fig. 6 is a perspective view of a portion of the rotor core showing compensation winding coils (17), main field permanent magnets (18), and rotor yoke segments made of soft magnetic material (19).

Fig. 7 is a perspective view of a portion of the rotor core showing compensation winding coils (20), main field permanent magnets (21), rotor yoke segments made of soft magnetic material (22), and auxiliary magnets (23).

DETAILED DESCRIPTION OF THE DRAWINGS

Fig. 1, the rotor of a PM machine is built out of pole segments (1), one or more short permanent magnets (2) per pole, and one long permanent magnet (3) per pole. The magnets (2) and (3) are magnetized so that their flux goes through the rotor yoke segments as shown with arrows in Fig. 1. With given magnetization directions, the sequence of poles on the rotor circumference is as usual, i.e. N – S – N – S – etc. The rotor structure in Fig. 1 enables discrete change of the induced voltage in the stator winding, as will be illustrated in the following discussion.

The rotor in Fig. 1 is placed in a stator with ordinary polyphase winding, fed presumably, but not necessarily, from an inverter which enables separate control of d- and q- axis currents. Assume that the rotor rotates at a given speed, and that the stator induced voltage has to be decreased for a fixed amount. In order to do that, additional component of current is forced to flow temporarily through the stator windings, the magnetic field of which is opposed to the magnetic field created by magnets 2 and 3. The amplitude of this control current is chosen in such a manner, that its magnetic field remagnetizes only those portions of permanent magnets (3) which are placed closer to the rotor bore, whereas the magnetization of the rest of magnets (3), as well of the whole magnets (2) remains unchanged. After the control current has flown for a short time, the magnets (2), as well as the parts of magnets (3) leaning on magnets (2) are magnetized so to drive the flux through rotor poles in the same direction as before. The parts of magnets (3) closer to the rotor bore, i.e. the ones surrounded completely by pole segments (1), have changed their magnetization directions in such a manner, that they now oppose the flux of the (predominating) rest of magnets (3) and complete magnets (2). As a result, the total flux per pole produced by rotor magnets is smaller than before, and the induced voltage in the stator winding decreases. A lower induced voltage at a given speed enables increase of the rotor speed without exceeding the maximum allowed voltage in the stator winding.

Fig. 2, the induced voltage in a PM synchronous machine can also be controlled continuously. In order to provide a possibility for continuous, or arbitrary change of the induced voltage, the rotor has to be built as shown in Fig. 2. The soft iron pole segments (4) are surrounded by trapezoidal permanent magnets (5). The trapezoidal form of permanent magnets enables variation of the radial height of remagnetized portion of magnets (5) as a function of the stator control current. Thus, at a given speed an arbitrary induced voltage in interval between 0

and V_{\max} can be obtained only by controlling the amplitude of the remagnetizing current. If the pole pieces (24) are made out of non-magnetic material, the armature reaction flux in the q-axis is minimized.

Fig.3, a synchronous machine with PM rotor can operate at various number of poles.

5 Referring to Fig. 3, each rotor pole contains optional squirrel cage bars (25), several trapezoidal iron segments (6), and rectangular permanent magnets (7), whereas stator (8) carries a Dahlander, PAM or PPM winding in slots (9).

When the machine shown in Fig. 3 is running at a given speed and with a given number of poles, the rotor magnets are magnetized predominantly in tangential direction, and the squirrel
 10 cage is not active. Immediately after the number of poles has been changed by the action of stator winding, additional component of stator current in reconnected stator windings, or current(s) in additional stator winding(s) will flow remagnetizing the permanent magnets (7), thus setting a new number of poles in the rotor. This current generates a torque with rotor cage currents. The change of the number of rotor poles is caused by appropriate stator winding
 15 reconnection, so that the number of poles on the both sides of the air gap is equal. The remagnetizing component of the stator current flows only a short period of time, just enough to change the direction of magnetization in rotor magnets.

Fig. 4, a PM synchronous machine that can operate with variable number of poles and variable induced voltage consists of a plurality of soft iron segments (10) per pole, a plurality of
 20 trapezoidal magnets (11) per pole, optional squirrel cage (26), and the stator (12) with slots (13), in which the winding is placed. The stator Dahlander, PAM or PPM winding can be reconnected mechanically and/or electronically, resulting in a new number of stator poles. The rotor structure in this figure can be considered as a combination of the rotor structures in Figs. 2 and 3.

When the rotor in Fig. 4 is running at a certain speed, the induced voltage in the stator winding can be controlled by temporarily flowing control currents in the stator windings. The amplitude and phase shift of the control currents are chosen in such a manner that only a portion of the rotor magnets is remagnetized.

5 When the number of poles of the rotor in Fig. 4 has to be changed, additional component of stator current in reconnected stator Dahlander, PAM or PPM windings, or current in additional stator winding(s) flows, which is large enough to remagnetize permanent magnets (11).

Fig. 5, the rotor of a PM synchronous machine with improved air gap field distribution consists of tangentially magnetized main field magnets (14), auxiliary field magnets (15), and
10 soft iron pole segments (16). When loaded with stator current at a given power factor, a PM synchronous generator based on this principle has an improved air gap flux distribution as compared to a standard generator. The reason for this is the magnetic field of auxiliary magnets (15), which can be so dimensioned to fully compensate for the effects of armature reaction at a given load and power factor.

15 Fig. 6, the rotor of a PM synchronous machine with full field control capability consists of control coils (17), permanent magnets (18) and soft iron pole segments (19). The permanent magnets are either tangentially magnetized, as shown in Fig. 6, or radially magnetized, as is the case in machines with rare earth permanent magnets. Each control coil can carry a separate current. The magnetic field created by control currents can improve the machine performance in
20 two manners: as an additional field excitation, or to compensate the armature reaction.

When the control coils are connected to create magnetic field in the direction of magnetic field of permanent magnets, the resulting field is determined both by permanent magnets and

control current. The main flux is created partially by permanent magnets, and partially by the control current. This way less current losses I^2R are needed to build the main flux.

When the control coils carry currents which create magnetic field spatially shifted to the field of permanent magnets, they can be used to compensate for the stator armature reaction. The control currents create an additional component of the air gap field, which compensated for the armature reaction field of the stator currents.

Fig. 7, the rotor of a PM synchronous machine with improved full field control capability consists of control coils (20), tangentially magnetized permanent magnets (21), rotor yoke iron segments (22) and radially magnetized permanent magnets (23). The main magnetic field, created by tangential and/or radial magnets is modified by currents in control coils. The action of auxiliary magnets and control currents is identical as described in sections related to Figs. 5 and 6.

It will be now appreciated that here have been presented synchronous machines with permanent magnets. The rotors of presented machines are built out of steel segments and permanent magnets. Some rotors have squirrel cages, or current carrying coils in addition. The rotor flux can be modified either by remagnetization of permanent magnets, or by an action of the control current. The stators of presented machines have either single-speed, or multiple-speed windings. The multiple-speed windings can be built either after Dahlander principle, or as pole- amplitude modulated (PAM), or pole- phase modulated (PPM) winding with toroidal coils, as described in US Patent 5,977,679.

While the invention has been described with particular reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements of the preferred embodiment without departing

from invention. As is evident from the foregoing description, certain aspects of the invention are not limited to the particular details of the examples illustrated, and it is therefore contemplated that other modifications and applications will occur to those skilled in the art. It is accordingly intended that the claims shall cover all such modifications and applications as do not depart from

5 the true spirit and scope of the invention.

Although the present invention has been described in detail with reference to certain preferred embodiments, other embodiments are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred embodiments herein.

What is claimed is:

1 1. A rotor of a synchronous machine, comprising:

2 an iron core segment per pole; and

3 at least two permanent magnets per pole.

1 2. A rotor, as set forth in claim 1, wherein said rotor has a plurality of poles.

1 3. A rotor, as set forth in claim 1, wherein said permanent magnets have rectangular shapes.

1 4. A rotor, as set forth in claim 1, wherein said permanent magnets are tangentially
2 magnetized.

1 5. A rotor of a synchronous machine, comprising:

2 two iron core segments with additional pole piece per pole; and

3 one permanent magnet per pole.

1 6. A rotor, as set forth in claim 5, wherein said rotor has a plurality of poles.

1 7. A rotor, as set forth in claim 5, wherein said permanent magnets have trapezoidal shapes.

1 8. A rotor, as set forth in claim 5, wherein said permanent magnets are tangentially
2 magnetized.

1 9. A synchronous machine with a rotor comprising:

2 one or more iron core segments per pole;

3 one or more permanent magnets per pole;

4 an optional squirrel cage; and

5 a stator with a winding selected from the group consisting of a Dahlander pole-
6 changing winding, a pole- amplitude modulated winding, and a pole- phase modulated winding
7 with toroidal coils.

1 10. A rotor, as set forth in claim 9, wherein said rotor has a plurality of poles.

1 11. A rotor, as set forth in claim 9, wherein said permanent magnets have rectangular shapes.

1 12. A rotor, as set forth in claim 9, wherein said permanent magnets are predominantly
2 tangentially magnetized.

1 13. A synchronous machine with a rotor comprising:

2 one or more iron core segments per pole;

3 one or more permanent magnets per pole;

4 an optional squirrel cage; and

5 a stator with a winding selected from the group consisting of a Dahlander pole-
6 changing winding, a pole- amplitude modulated winding, and a pole- phase modulated winding
7 with toroidal coils.

1 14. A rotor, as set forth in claim 13, wherein said rotor has a plurality of poles.

1 15. A rotor, as set forth in claim 13, wherein said permanent magnets have trapezoidal
2 shapes.

1 16. A rotor, as set forth in claim 13, wherein said permanent magnets are predominantly
2 tangentially magnetized.

1 17. A rotor of a synchronous machine, comprising:

2 one iron core segment per pole;

3 one tangentially magnetized permanent magnet per pole; and

4 one or more coils per pole.

1 18. A rotor, as set forth in claim 17, wherein said rotor has a plurality of poles.

1 19. A rotor, as set forth in claim 17, wherein said permanent magnets are tangentially
2 magnetized.

1 20. A rotor, as set forth in claim 17, wherein said coils can be separately excited.

- 1 21. A rotor of a synchronous machine, comprising:
2 one iron core segment per pole;
3 one tangentially magnetized permanent magnet per pole;
4 one radially magnetized permanent magnet per pole; and
5 one or more coils per pole.
- 1 22. A rotor, as set forth in claim 21, wherein said rotor has a plurality of poles.
- 1 23. A rotor, as set forth in claim 22, wherein said coils can be excited separately from each
2 other.
- 1 24. A rotor of a synchronous machine, comprising:
2 two iron core segments per pole; and
3 two tangentially magnetized permanent magnets per pole.
- 1 25. A rotor, as set forth in claim 24, wherein said rotor has a plurality of poles.

MEANS FOR FIELD CONTROL IN PERMANENT
MAGNET ELECTRIC MACHINES

Abstract

The present invention is a rotor apparatus in which the shape and magnitude of magnetic
5 field distribution along the rotor circumference are controlled by means of current(s). The control
current(s) can flow only during the phase in which a new magnetic state is created, or
permanently. When the rotor magnetization is controlled by additional stator currents, the stator
of the proposed machine draws during regular run only the load current. In one embodiment, the
rotor of a synchronous machine has iron pole segment (1) and two or more tangentially
10 magnetized permanent magnets (2), (3) per pole with different radial dimensions. On the stator
side a conventional AC winding carries stator currents during normal operation. During a short
remagnetization phase, an additional component of stator current provides for change of
magnetization direction in a portion of longer magnets.

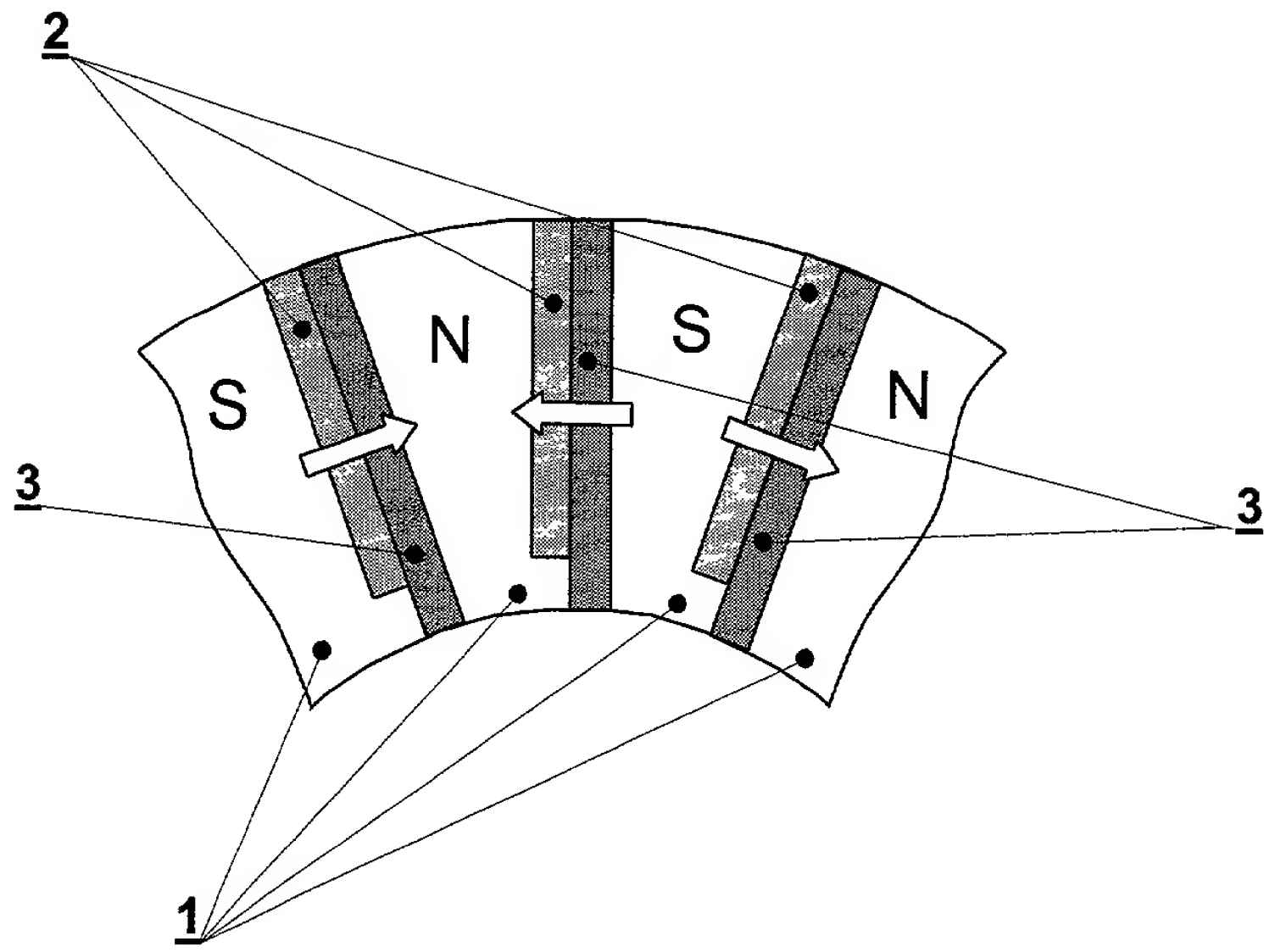


Fig. 1

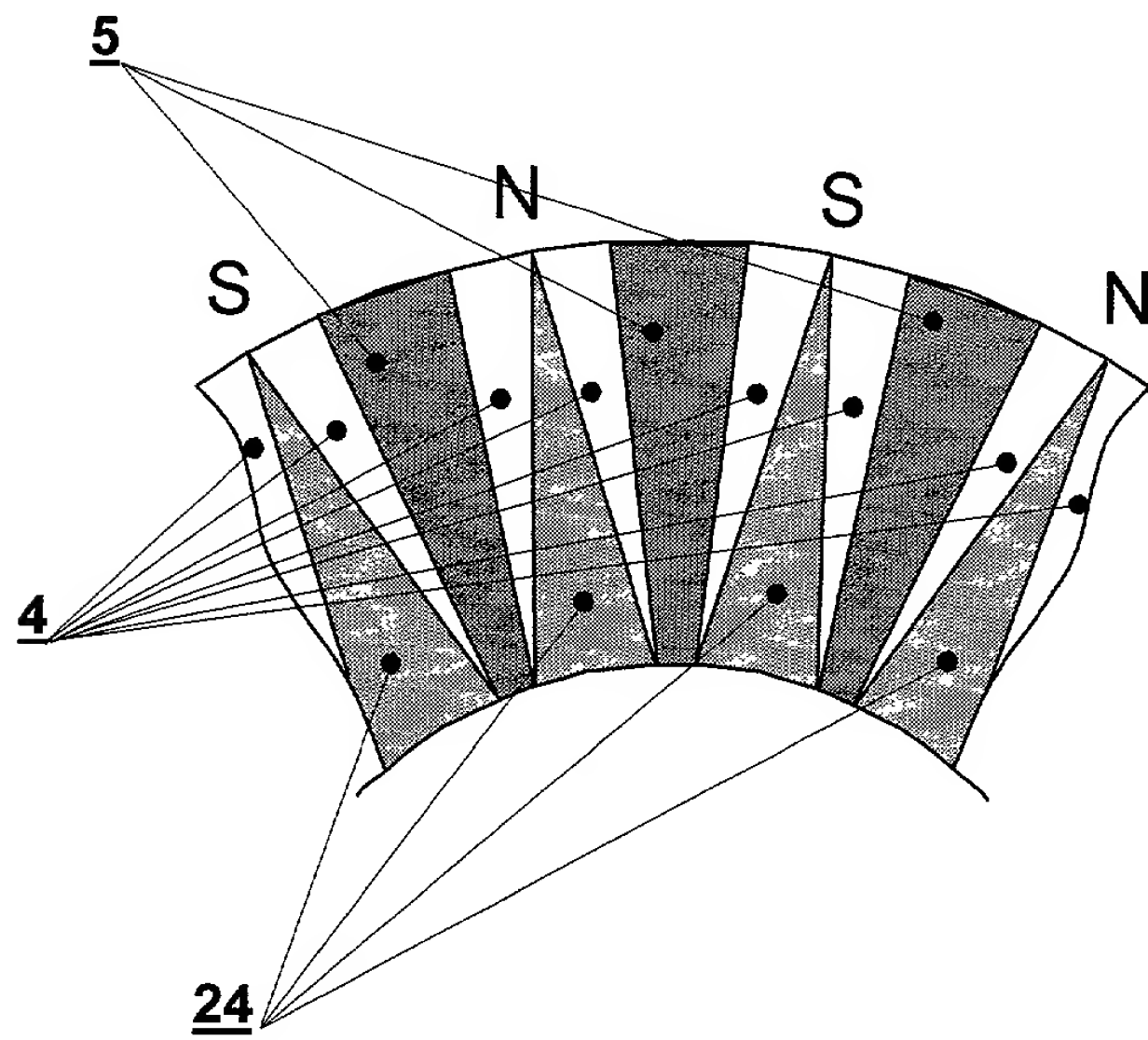


Fig. 2

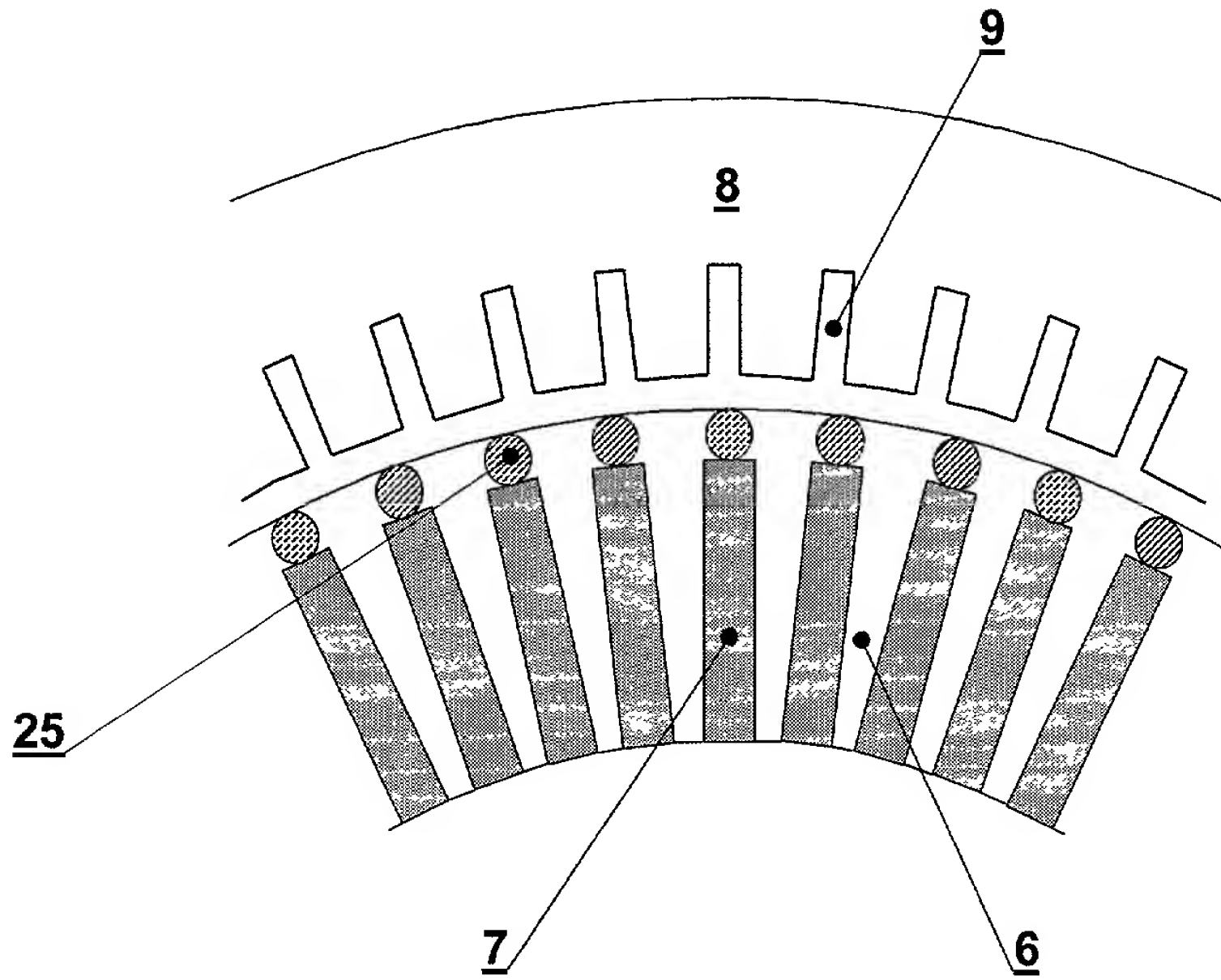


Fig. 3

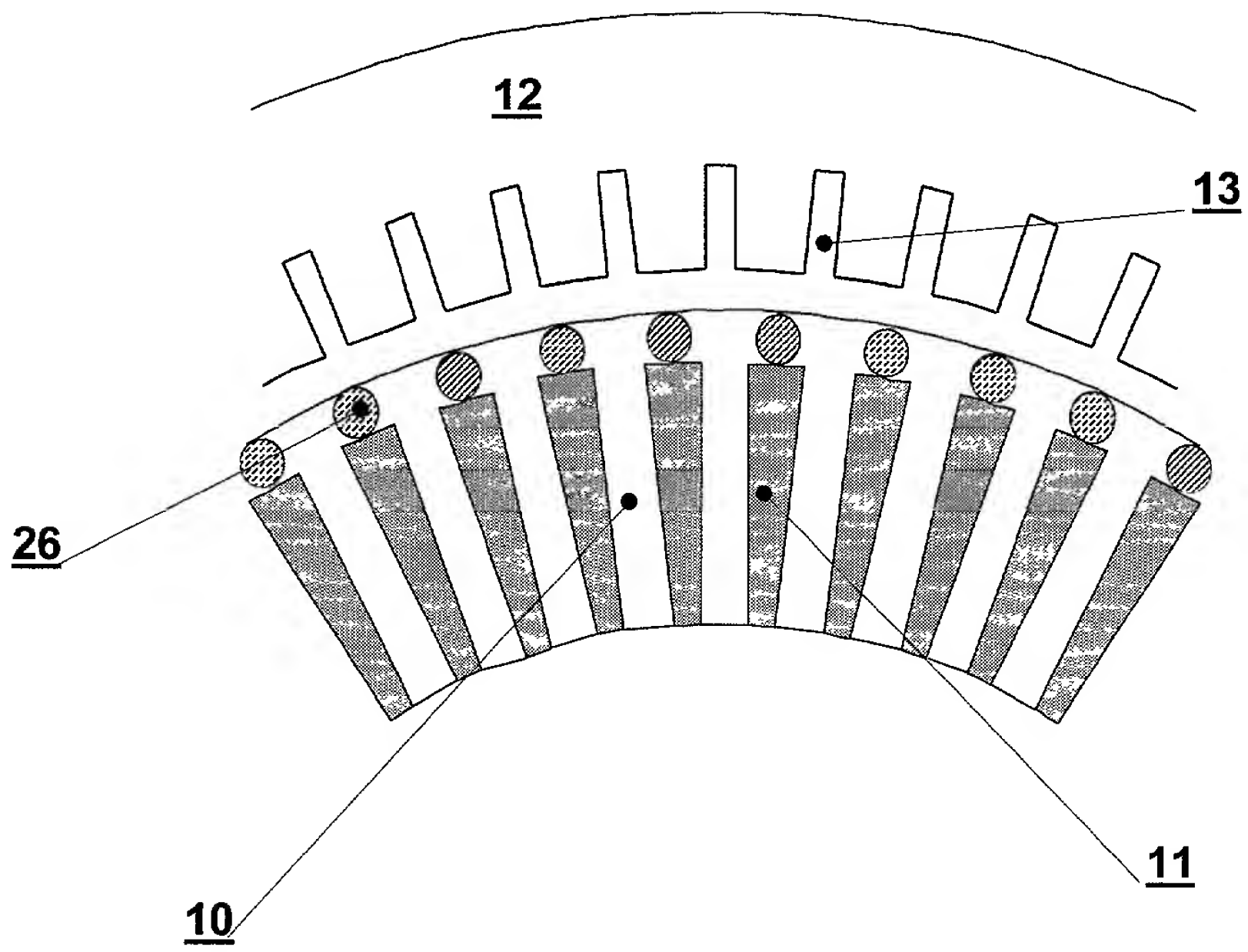


Fig. 4

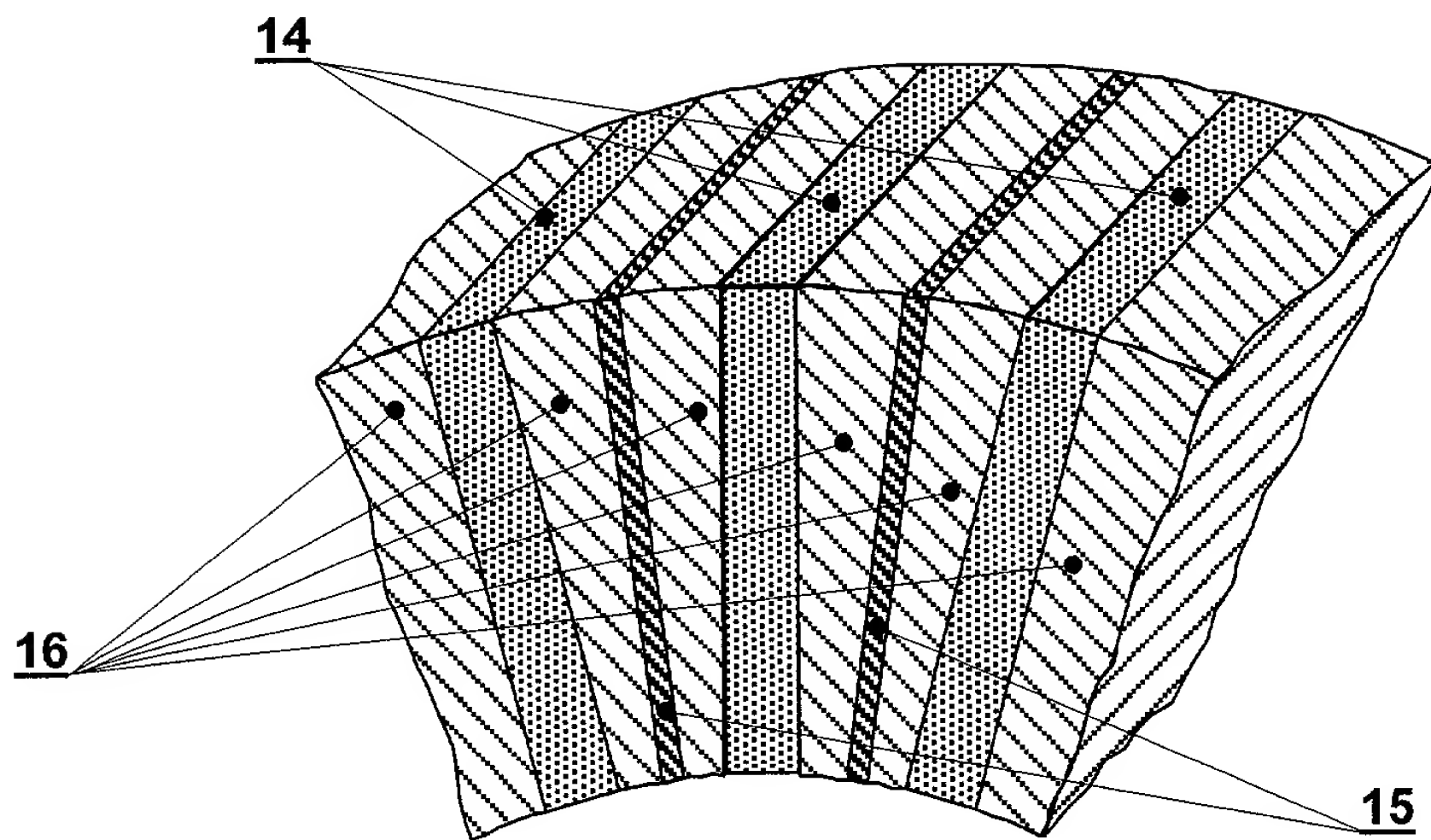


Fig. 5

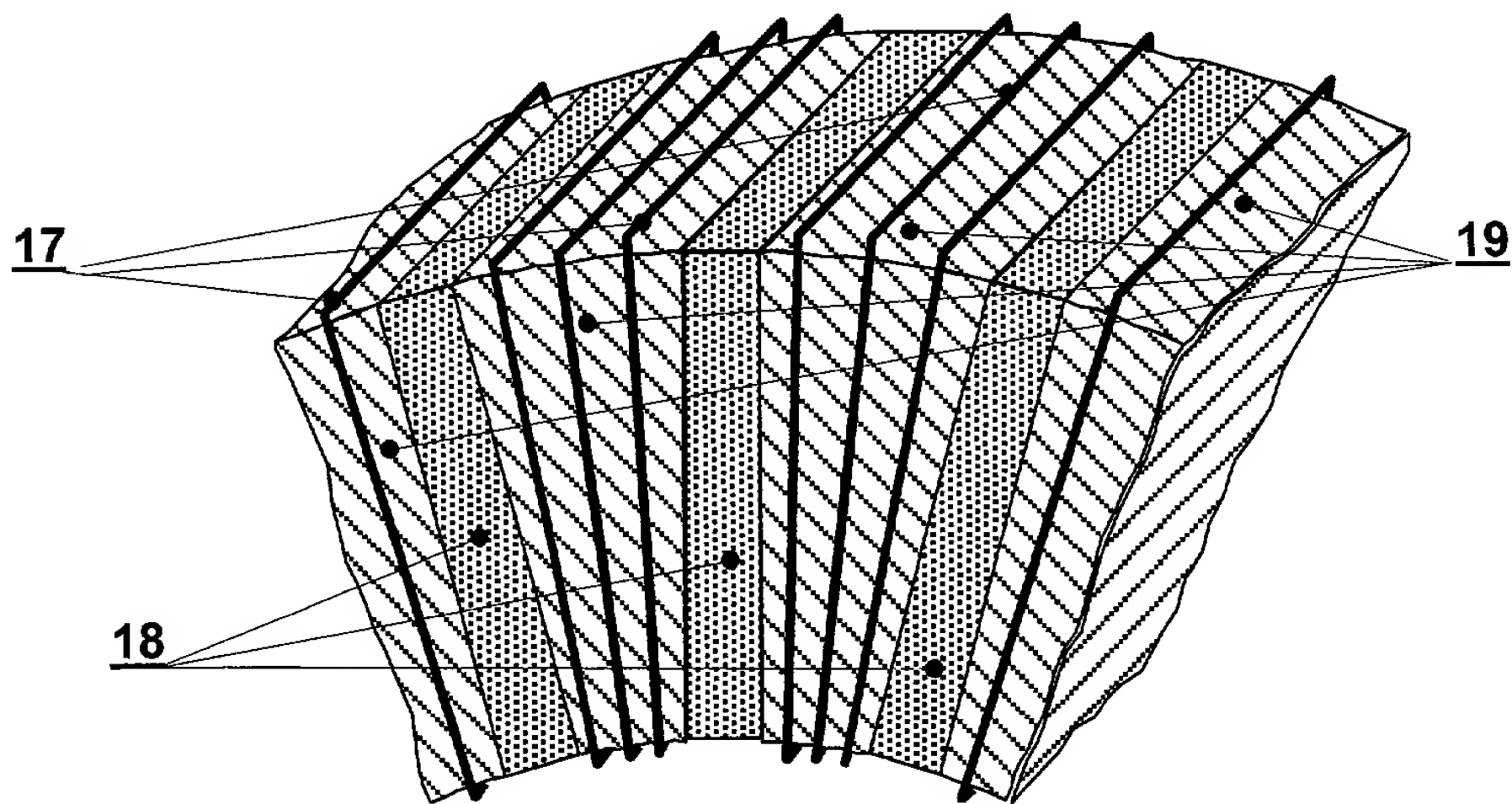


Fig. 6

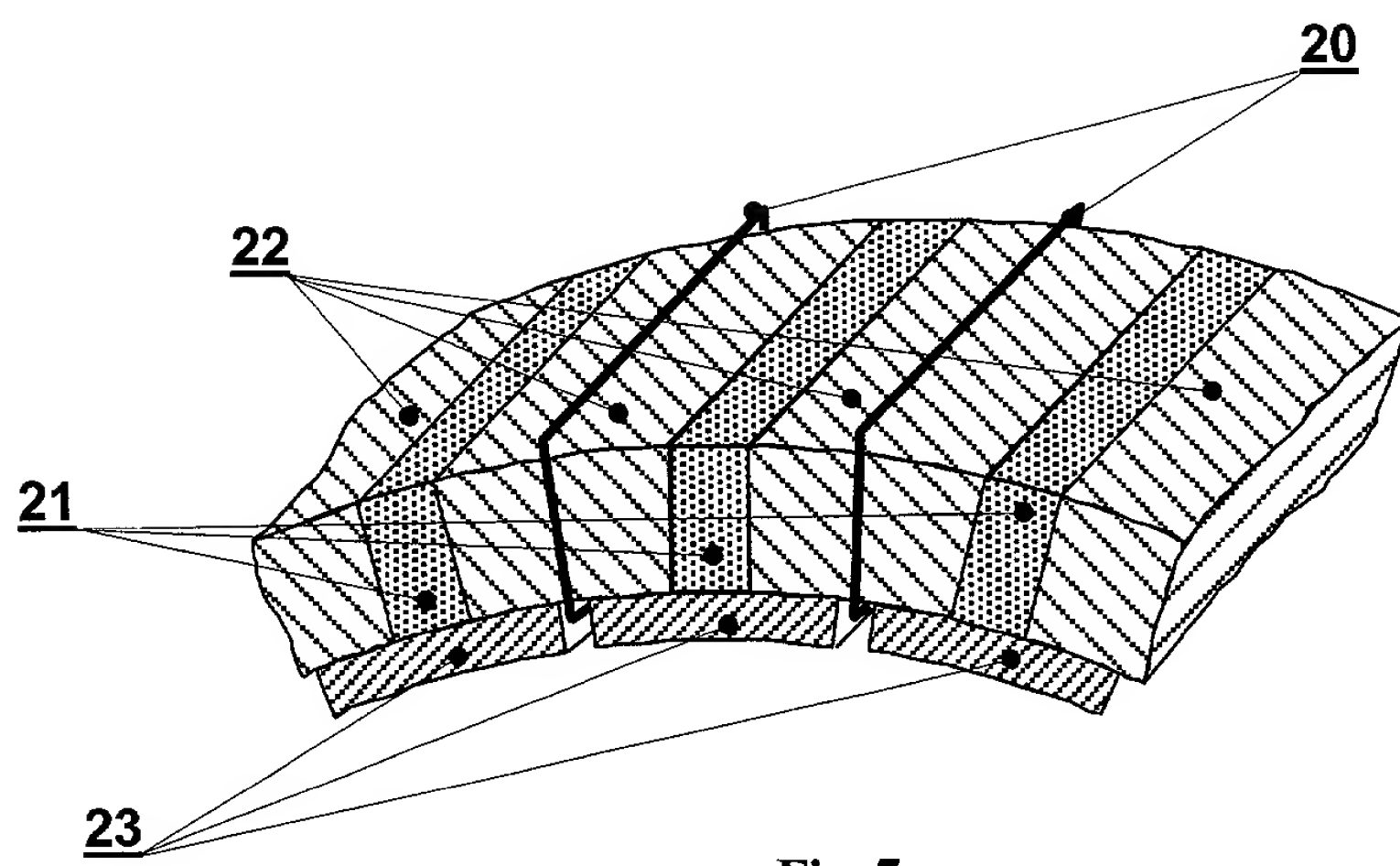


Fig. 7

PATENT APPLICATION

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

ATTORNEY DOCKET NO. 800448

As a below named inventor, I hereby declare that:

My residence/post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Means for Field Control in Permanent Magnet Electric Machines

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as US Application Serial No. or PCT International Application
Number _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose all information which is material to patentability as defined in 37 CFR 1.56.

Foreign Application(s) and/or Claim of Foreign Priority

I hereby claim foreign priority benefits under Title 35, United States Code Section 119 of any foreign application(s) for patent or inventor(s) certificate listed below and have also identified below any foreign application for patent or inventor(s) certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NUMBER	DATE FILED	PRIORITY CLAIMED UNDER 35 U.S.C. 119
Germany	Nr. 197 57 502.1	Dec. 12, 1997	YES: _____ NO: _____
Germany	Nr. 197 57 502.1-32	Nov. 9, 1999	YES: <input checked="" type="checkbox"/> NO: _____
Germany	Nr. 194 14 759.7	Apr. 2, 1998	YES: _____ NO: _____
Germany	Nr. 198 14 759.7-32	Nov. 15, 1999	YES: <input checked="" type="checkbox"/> NO: _____
Germany	Nr. 199 43 274.0	Sept. 9, 1999	YES: <input checked="" type="checkbox"/> NO: _____
Germany	Nr. 199 46 648.3	Sept. 29, 1999	YES: <input checked="" type="checkbox"/> NO: _____

Provisional Applications

I hereby claim the benefit under Title 35, United States Code Section 119(e) of any United States provisional application(s) listed below:

APPLICATION SERIAL NUMBER	FILING DATE

U.S. Priority Claim

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NUMBER	FILING DATE	STATUS(patented/pending/abandoned)

POWER OF ATTORNEY:

As joint inventor, I hereby appoint the following attorney(s) and/or agent(s) listed below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Gail M. Taylor Russell, Reg. No. 36,290

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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